

Seksjon for porøse mediers fysikk

= X-Ray Physics Group + SFF PoreLab



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NTNU Strategic Areas



Energy
Health
Oceans
Sustainability

Current projects:

- 2 FRINATEK
- 2 NANO2021
- 1 Petromaks-2
- 1 EU project (INFRAIA)
- 1 NTNU/DTU collaboration
- 1 NV/AVIT: Phase contrast CT

- *We're well funded!*



How to choose your 5th year project?

Consider it a unique opportunity to

- Do independent & uninterrupted curiosity-driven *science* for several months!
- Get deep knowledge of a research topic that really *interests* you
- To be deeply integrated into the daily rhythm of a research group
- To work with state-of-the-art instruments / algorithms / theories
- To prepare for your next professional step (Industry? Academia?)

Be independent! Follow your own interests!

Contact a professor that you like! Ask!



X-Ray Physics Group, 2019

Fourier Ptychographic Microscopy



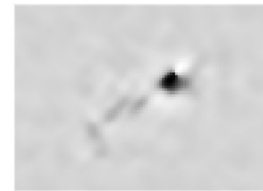
Head engineer Katharina and former MSc students Knut Olav Schnell (MTNANO) and Elisabeth Karud (MTFYMA).

Quantitative phase microscopy.

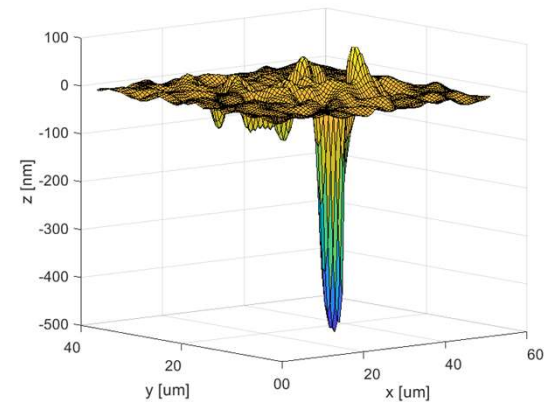
Here: Measurements of surface defects («flaws») in glass.

Why is that difficult?
Why is that important?
Who is interested?

- very little contrast.
- *safety!*
- *Car industry!*
(SFI CASA, Audi, BMW, St. Gobain)
- *anti terrorism*

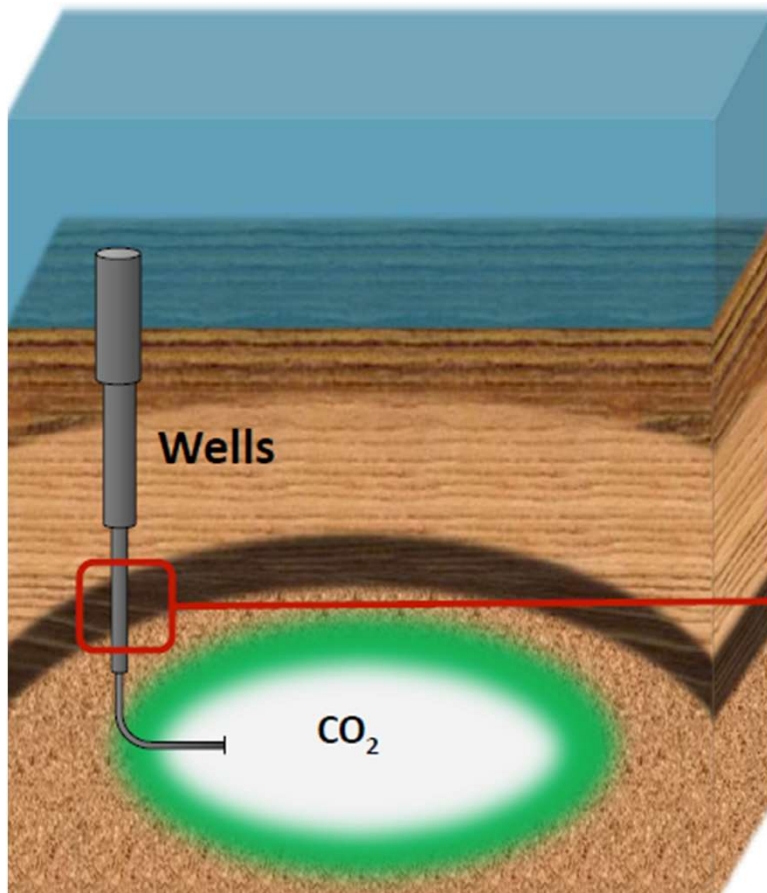


Diameter ~5 micron
Depth ~ 500 nm



4D X-ray Microscopy

In situ well-conditions, CO₂ exposure of cement
CO₂ storage, cement plugging:



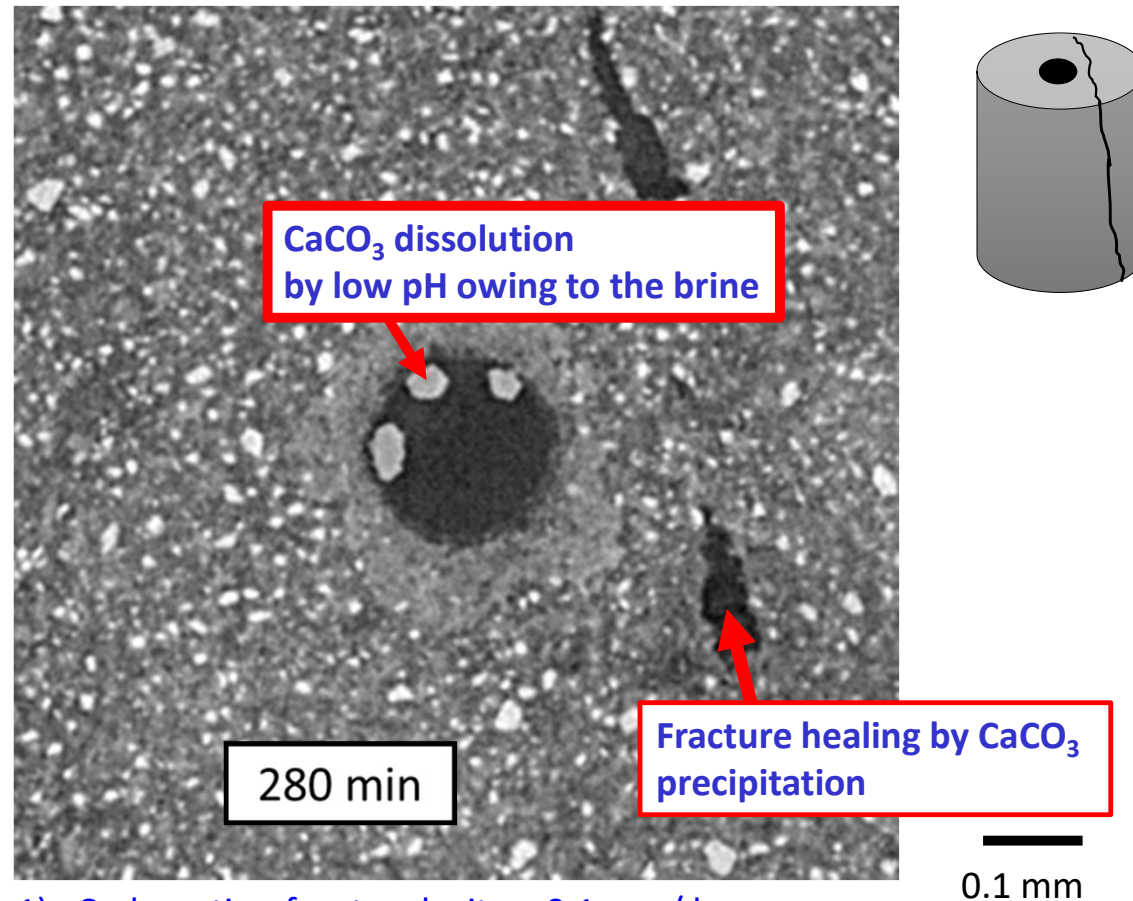
High T , high p
→ CO₂ is in supercritical state
How is cement affected?



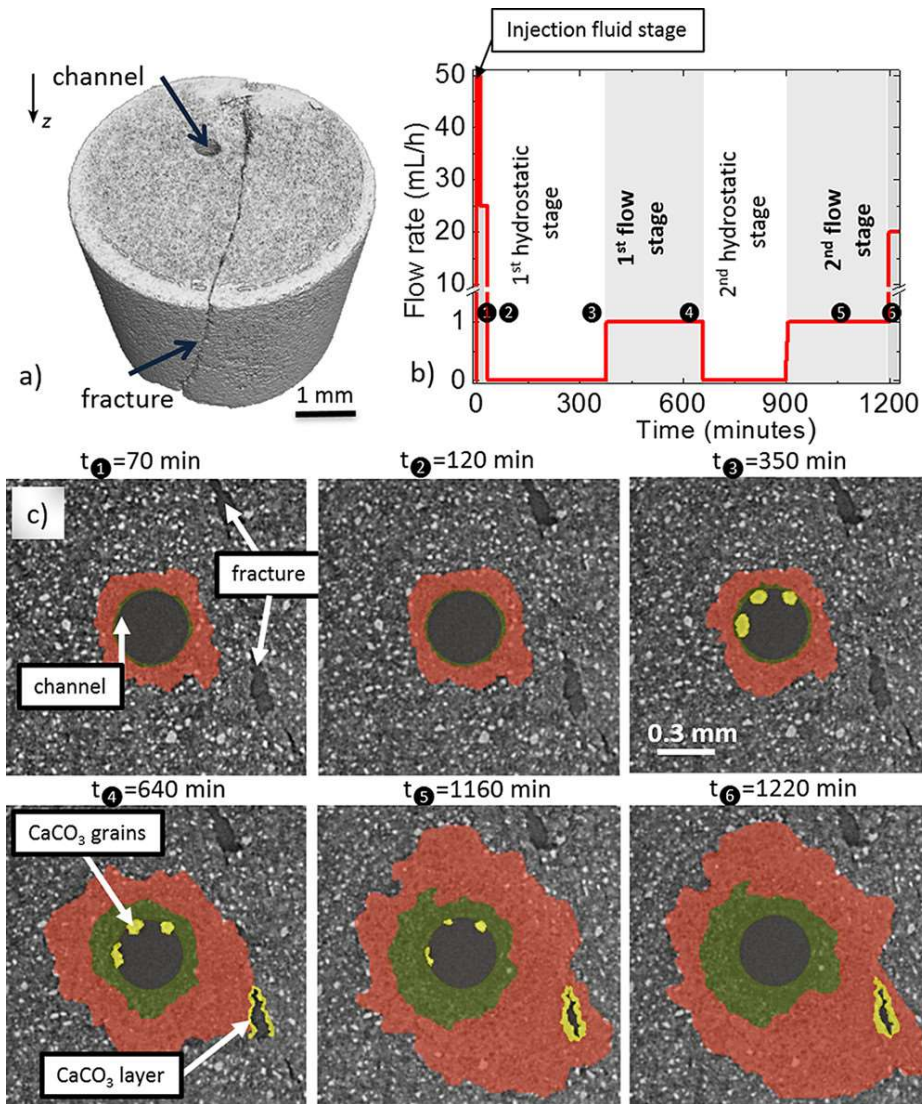
HADES cell.

In situ CO₂-brine exposure of cement plug

Realistic well conditions: $p = 280 \text{ bar}$; $T = 80^\circ\text{C}$; Flow conditions $1 \text{ mL/h CO}_2\text{-brine}$

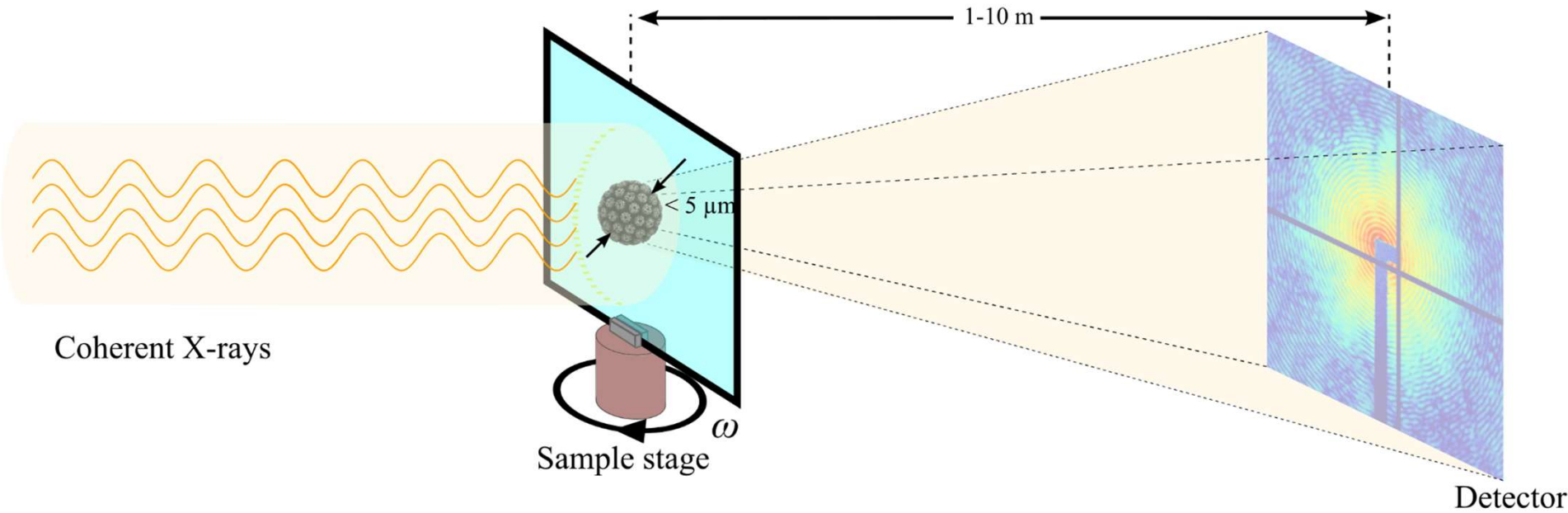


- 1) Carbonation front, velocity $< 0.1 \text{ mm/hour}$
- 2) Dissolution of CaCO₃ front



Contributions by
MTFYMA student Ingrid
Børve.

Coherent X-ray Diffraction Imaging & Ptychography

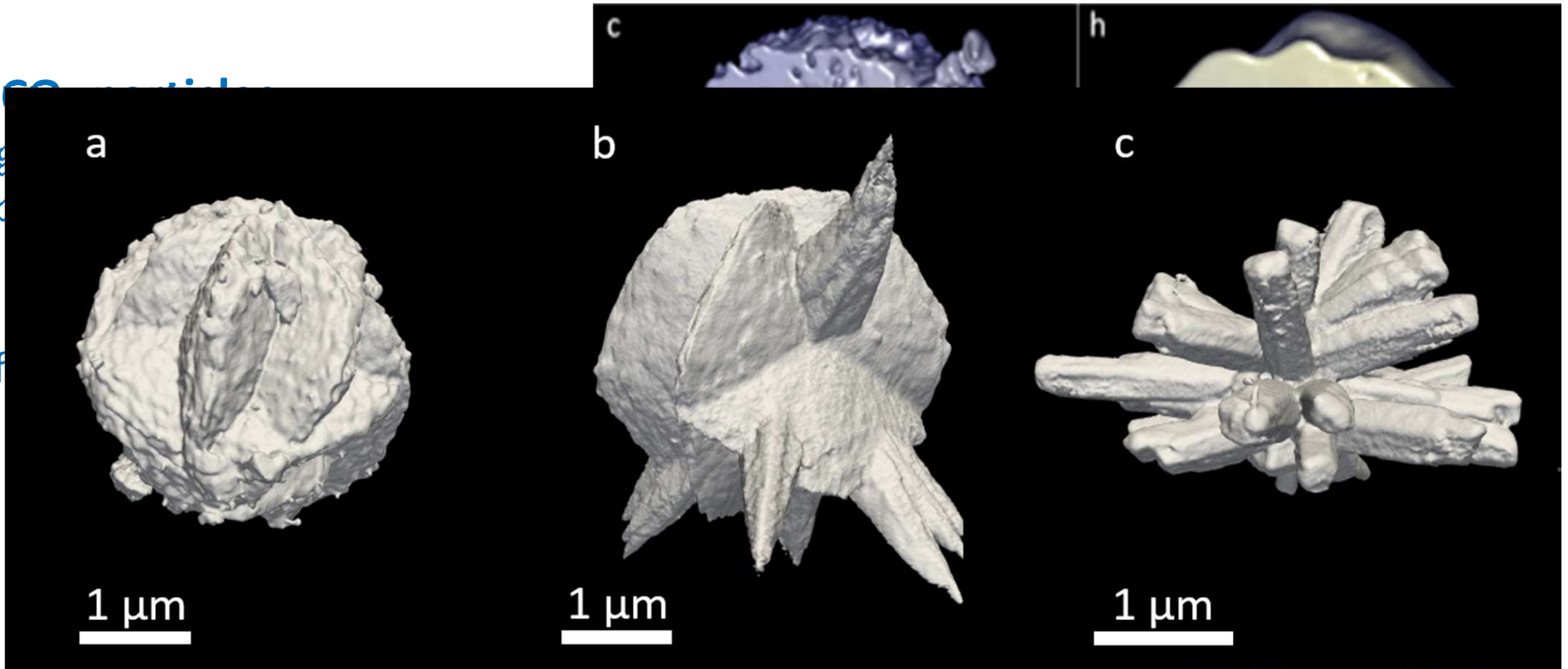


$I \sim |\text{F.T. } \{\psi\}|^2$ Phase information is lost when measuring the intensity.
But: **Coherence** allows numerical phase retrieval. \rightarrow **Phase problem is solved!**

CaCO₃ crystals

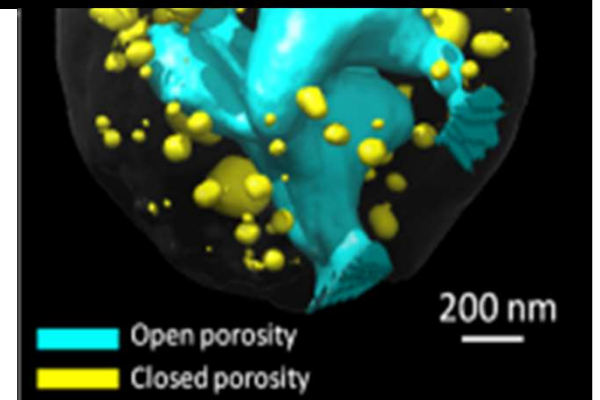
(e.g. paper)

3D
before



Cherkas *et al*
J Cryst Growth & Design, 2017

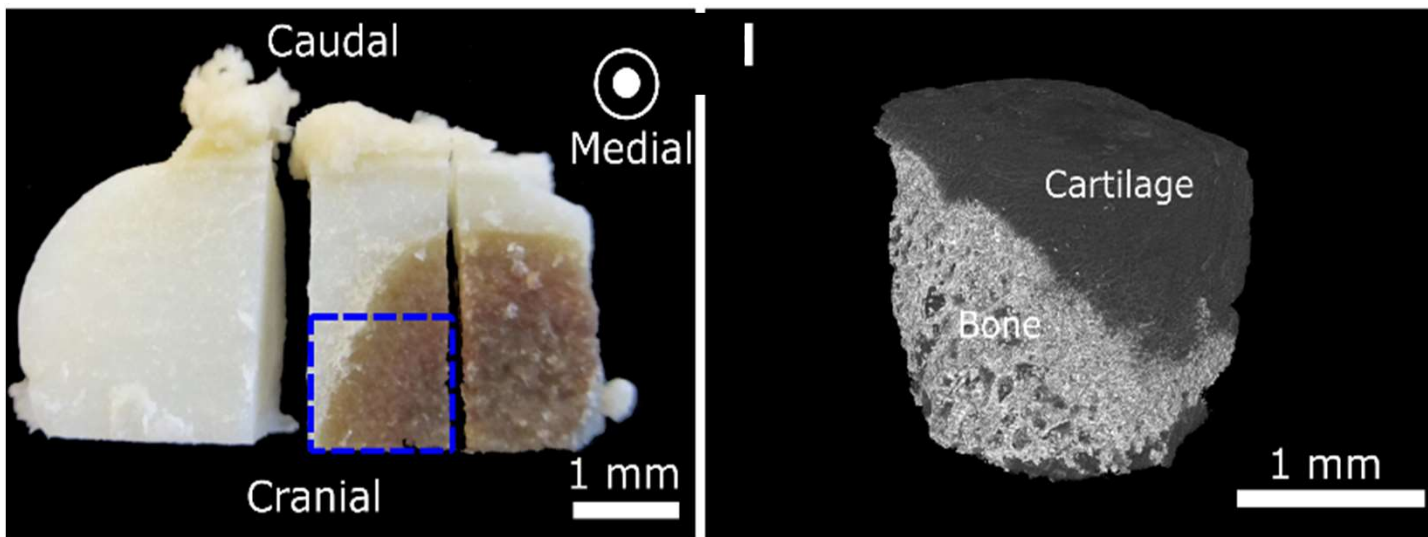
Daniyal *et al*
To be published



XRD-CT *conts.*

Now: Piglet bone & cartilage

- young piglet knee joint
- Cartilage (“brusk”) and bone
- Scientific questions:
 - Bone mineralization **orientation** near bone-cartilage interface?



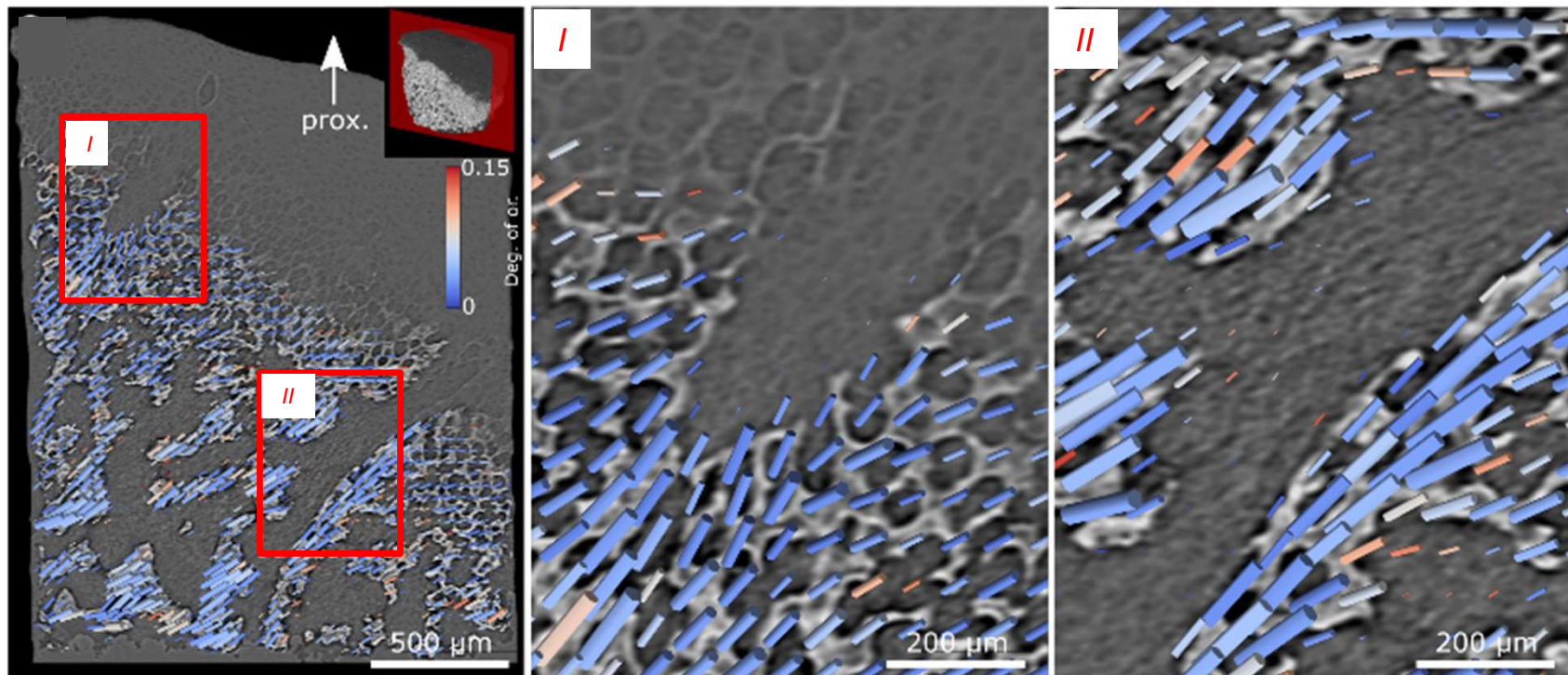
(Photograph)

(Ordinary X-ray CT)

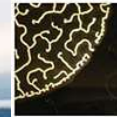
XRD-CT: Piglet bone (002_{HA}) orientation

Here:

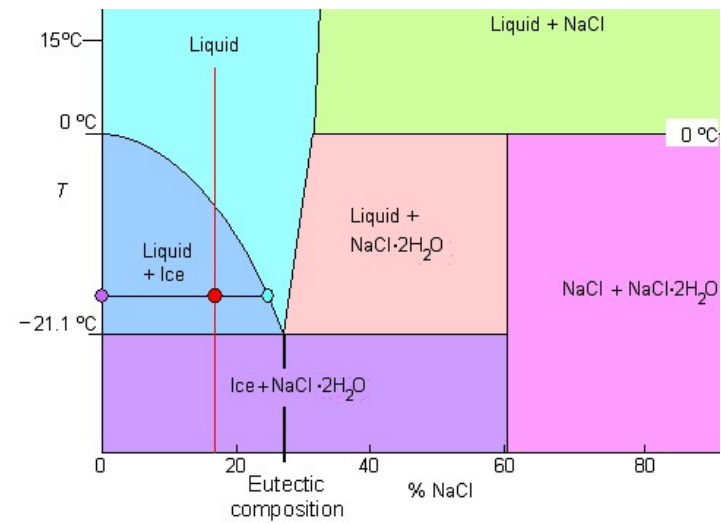
- Oriented HA crystallites (c-axis) overlaid on phase contrast CT
- voxel size ($50 \mu\text{m}$)³
- Data set is **6D**: position + orientation



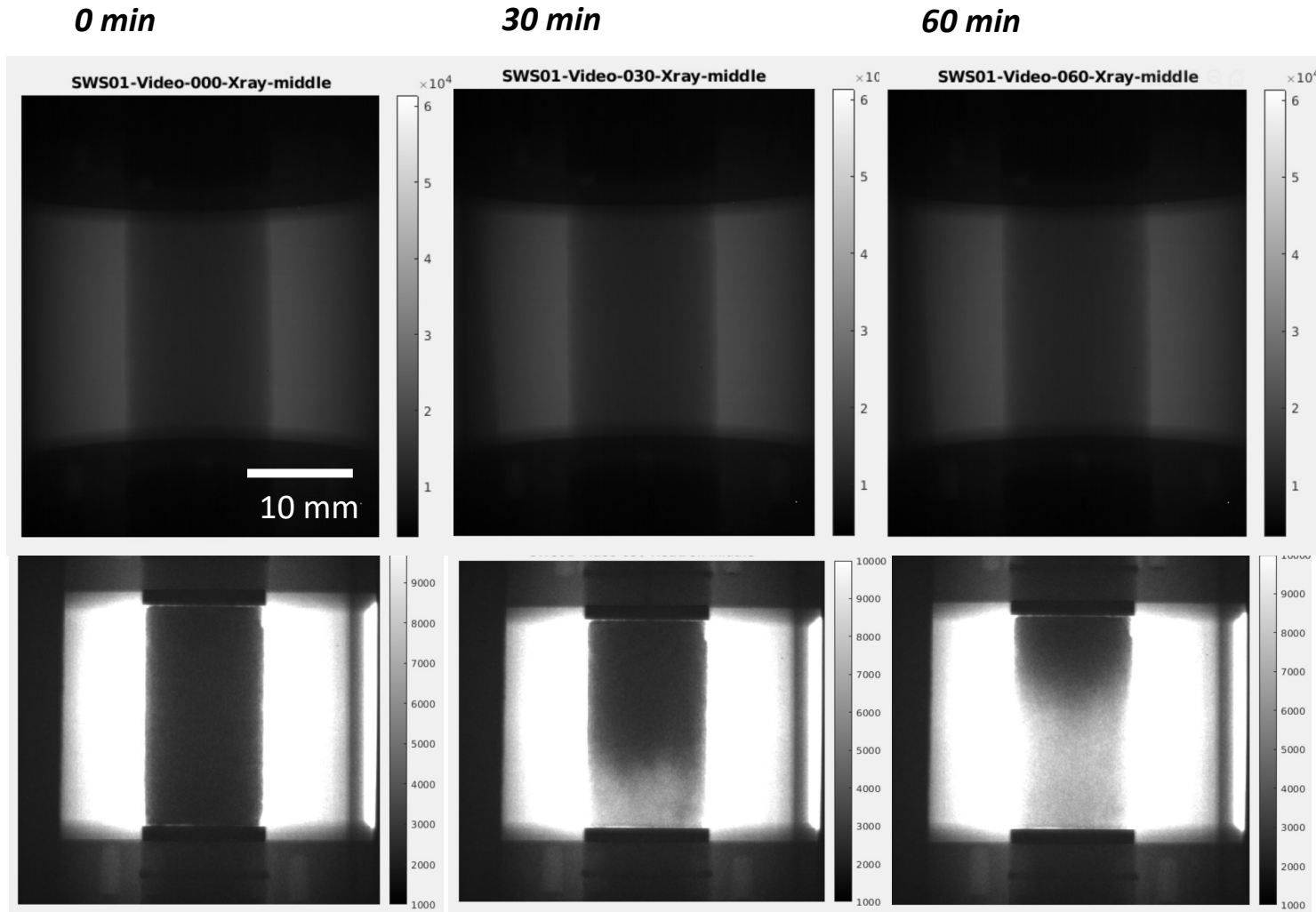
Societal and environmental physics.
Sustainability
nano $\leftarrow \rightarrow$ *macro*



PoreLab
NTNU-UiO Porous Media Laboratory



«Saltwash South» – a soft, salt-stabilized rock. Here: absorbing water.



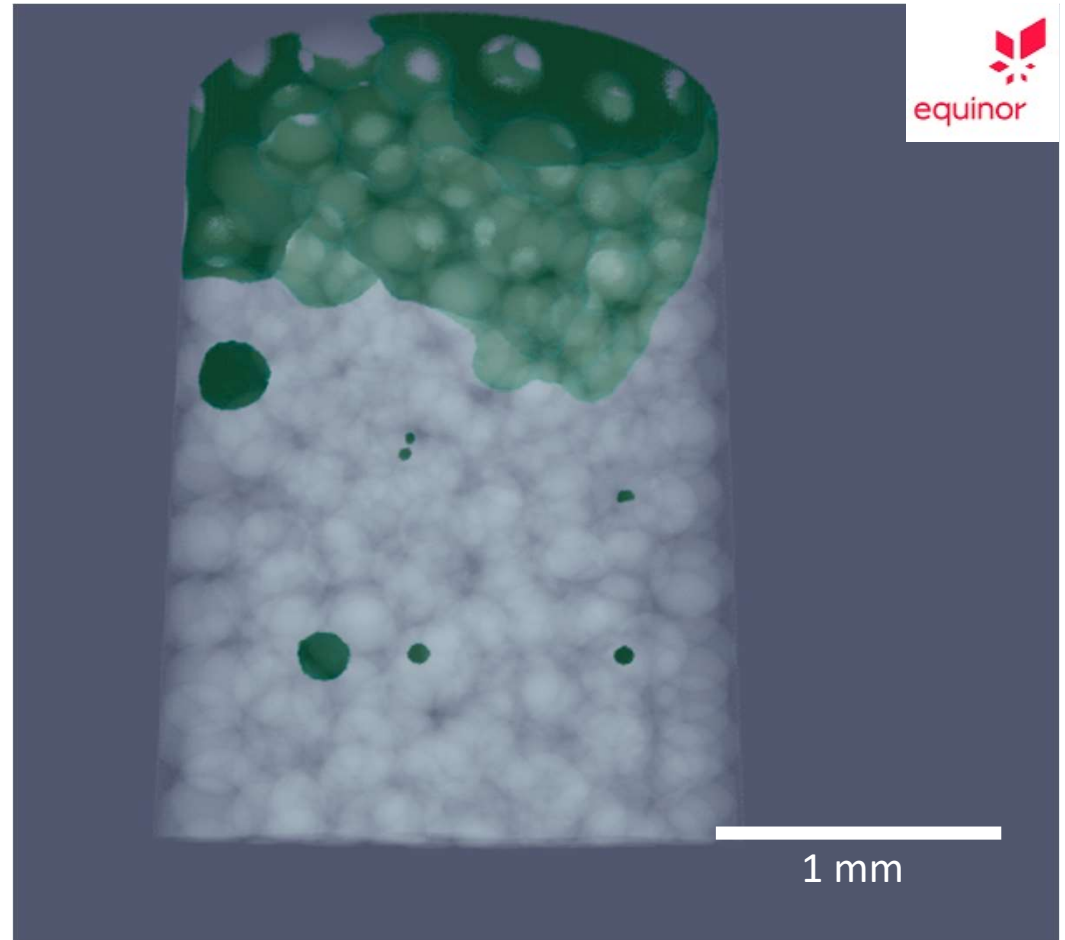
X-ray radiography

Simultaneous
neutron
radiography!
@ PSI-SINQ
@ ILL

Multiphase flow in porous media



Drainage:
Air (green) replacing water (white)



Tekseth *et al*, In preparation

Prosjekt/Master innen Røntgenfysikk – vi tilbyr:

- Prosjekt innen materialfysikk
 - *kombinasjon av eksperiment, analyse, simuleringer og teori*
- **Opplæring** i bruk av fancy vitenskapelig utstyr
- Programmeringsoppgaver, inkl. **AI / Machine Learning / Compressed sensing**, parallellisering (GPU) og Big Data analyse (TB)
- **Industri-relevante** oppgaver
 - *Men: uomtvistelig akademisk!*
- **Ukentlige møter** med veileder
- Delta i **internasjonal forskning!**
(Utvekslingsmuligheter!)

Kom og snakk med oss!

